National Aeronautics and Space Administration

technology opportunity

Metallic Foam to Reduce Turbofan Engine Noise

Aircraft engine noise plagues communities near airports. Acoustic liners to reduce aircraft engine fan noise have been placed upstream and downstream of the rotor fan but not in the area immediately over the fan. This new metallic foam innovation behaves like a bulk acoustic liner, serves as a tip rub strip, and can be integrated with a rotor containment system to increase the noise-suppression treatment area.

Benefits

- **Effective:** By increasing the noise-suppression treatment area and its proximity to the noise source, the foam absorbs more sound from aircraft engine fans.
- **Safe:** The noise-suppressant metallic foam doubles as a rotor-tip rub strip.
- **Durable:** The material can withstand high heat and temperature variations in freeze-thaw cycles, and maintains its efficacy even when compressed or after absorbing hydraulic fluids.
- **Does not impede aerodynamics:** The foam fits into the rotor casement with minimal, if any, aerodynamic penalty.

Applications

- Engine or nacelle manufacturers
- Ground power systems
- Cooling/ventilating fans
- Ducted propellers

Technology Details

How It Works

Acoustic liners have desirable acoustic attenuation properties and thus are commonly used to reduce noise in jet engines. The liners typically are placed upstream and downstream of the rotors (fans) to absorb sound before it propagates out of the inlet and exhaust ducts. Noise attenuation could be dramatically improved by increasing the area over which a noise-reducing material is applied and by placing the material closer to the noise source.

Researchers at NASA Glenn and NASA Langley have discovered that the Haynes® 25 metallic foam is compatible with the environment in the region close to the rotor blades. The Haynes 25 metallic foam achieves the twin goals of increasing the area covered by the noise-attenuating material and bringing it closer to the noise source. NASA also is working on alternative foam materials that are lighter and provide acceptable acoustic performance. Although the current work is applied to a fan, the high temperature capability of the metal foams enables applications to engine core components such as the turbine.

Why It Is Better

For many years, engineers have known that bulk acoustic liners provide better noise reduction over a range of frequencies. However, materials currently available are not well-suited for use in the harsh environment within a jet engine. Previous attempts at providing acoustic liners that could withstand these harsh conditions resulted in materials that reduced aerodynamic performance and could not hold up against rotor-tip rub, making them unsuitable for use in the region over the fan rotor.

Researchers at NASA Glenn and NASA Langley have acoustically tested the Haynes 25 metallic foam, which significantly reduces noice over a range of frequencies and fan speeds. Besides having these favorable bulk acoustic liner properties, the material can withstand the harsh engine environment and can be designed to minimize aerodynamic losses. The new metallic foam acoustic liner material has been shown to have a long life in an oxidizing environment, withstanding a temperature of 1000°C in a burner rig for 30 minutes. The foam does not readily absorb fluids, such as hydraulic fluid, that reduce the material's efficacy. Nor have the freeze-thaw cycles, inherent in moving between high altitudes and ground level, resulted in the structural concerns associated with bulk acoustic materials currently on the market. Stress tests revealed that the metallic foam can withstand expected mechanical loads, having held up well under compression, bending, and tensile stress.

The Haynes 25 metalic foam can double as a rotor-tip rub strip. Replacing the rub-strip layer in the containment system surrounding the fan rotors with this acoustic metallic foam brings a noise-reduction material into this region. The material properties of the foam, such as temperature, density, porosity, and weight can also be tailored to suit a specific application.

While the current work is intended to reduce turbofan noise, the method is applicable to other applications such as ground power systems and ventilating fans.

Patents

Patent pending.

Licensing and Partnering Opportunities

NASA invites companies to discuss licensing or partnering opportunities involving this innovative Metallic Foam Acoustic Liner technology for commercial applications.

For More Information

For more information about this and other technology licensing opportunities, please visit:

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